



INSTRUCTION MANUAL

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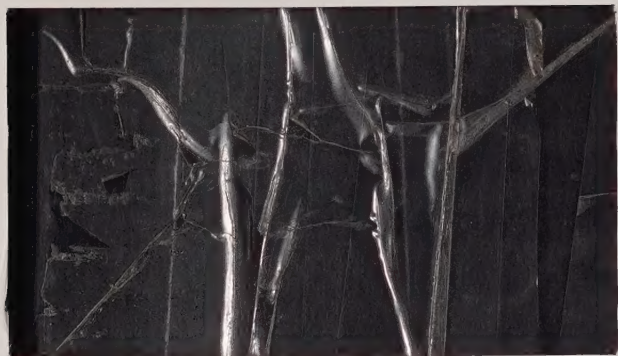
BARBER-COLMAN COMPANY

Industrial Instruments Div. • Rockford, Ill., U.S.A.

MP MASTER



MA32104



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IN 6-2

SERIES 273B - 273C

CAPACITROLS

INTRODUCTION

This instruction manual is designed to help you secure maximum benefits from your new Series 273B/273C Capacitrol. It should be given to persons responsible for installation, operation and maintenance of this instrument.

Your Barber-Colman factory trained field engineer is always available for further help in the solution of your control problems. Offices are located in all principal cities.

BARBER-COLMAN COMPANY
Industrial Instruments Division

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SPECIFICATIONS

Meter

Scale Length	5 inches
Minimum Span	12 mv or 0-400°F - Type J
Calibrated Accuracy	± 1% of full scale
Sensitivity	90 microamps for full scale deflection (nominal)
Internal Resistance	11 ohms per millivolt (nominal)
External Resistance	Calibrated for 15 ohms and supplied with replaceable compensator to make up difference between calibrated resistance and actual value of external resistance
Compensation	a) Automatic cold junction temperature compensation Range 32 to 130°F b) Copper coefficient compensation Range 32 to 130°F

Chassis

- NOTE -

The Series 273B and 273C combine two points of control into one instrument. Control action may be on-off or time proportioning at either or both points.

Thermocouple Break Protection	TCB furnished
Control Sensitivity	0.1 of 1% of full scale
Control Contacts	Two sets of SPDT contacts

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Chassis (continued)

Contact Ratings:		<u>120 v</u>	<u>240 v</u>
Time Proportioning	Resistive Loads	5 amps	2.5 amps
	Inductive Loads	2.5 amps	1.25 amps
On-Off Action	Resistive Loads	10 amps	5 amps
	Inductive Loads	5 amps	2.5 amps
Proportioning Band (Time Proportioning)	Fixed at 2% of full scale		
Cycle Time (Time Proportioning)	Adjustable from approximately 3 to over 30 seconds		
Control Point Spread	<u>Series 273B</u>	<u>Series 273C</u>	
	0-20% of full scale, above lower set point	0-100% of full scale	
Power Requirements	18 volt amperes		
Power Supply	Interchangeable: 120 and 240 volts a-c, 50/60 cycle		

Dimensions and Weights

Overall Dimensions	6 7/8" W x 6 1/4" H x 9 5/8" D
Cutout for Flush Mounting	6 1/8" W x 5 9/16" H

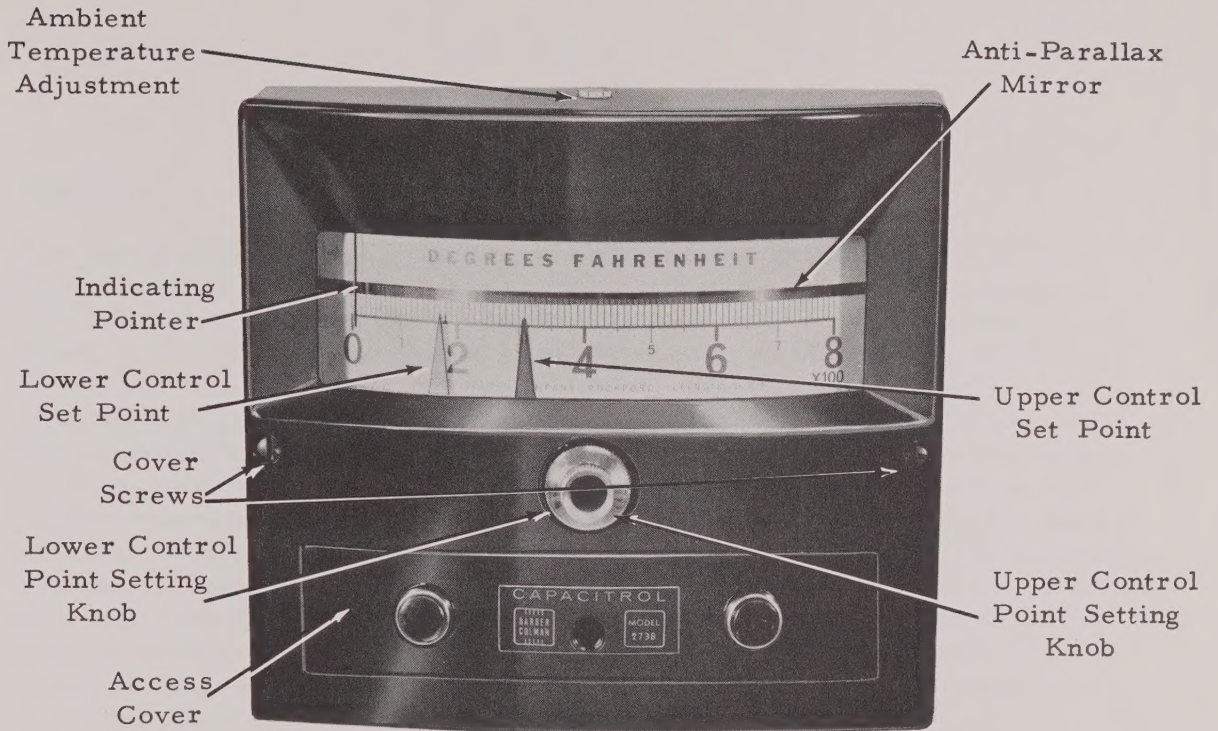
NOTE: Meter housing will extend
approximately 8" from back
of panel when flush mounted

Net Weight	12 pounds
Shipping Weight	15 pounds

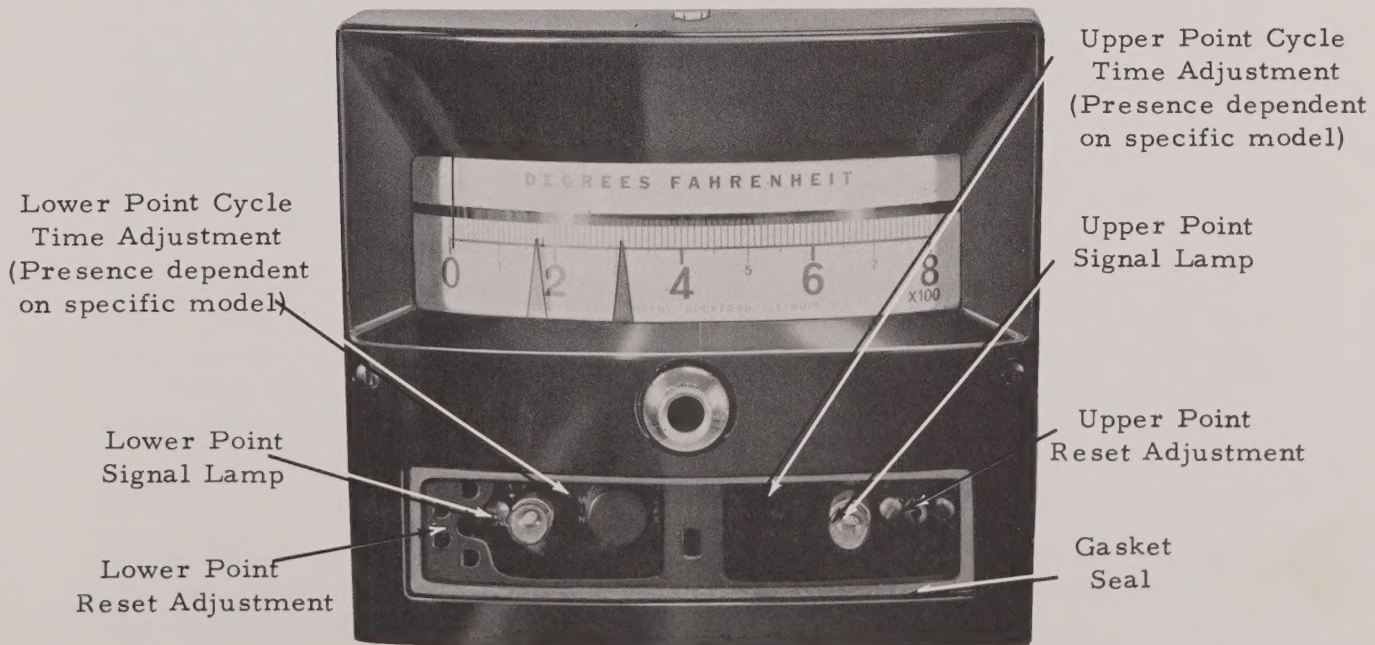
M A T E R I A L W A R R A N T Y

All equipment except tubes, photocells, and thermocouples, which within one year from date of shipment is found to have been originally defective, will be repaired (replaced if necessary) free of charge if returned prepaid to the Factory at Rockford, Illinois.

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MODEL 273B-1 CAPACITROL



FRONT VIEW - ACCESS COVER REMOVED



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SECTION I

DESCRIPTION

General

The Series 273B and 273C Capacitrols are three-position millivoltmeter-type indicating controllers. They are classified as three-position controllers because two relays allow control action to occur at two different points on the scale, giving three possible control combinations. Both series combine two points of control action. These may be on-off or time proportioning at either or both points, depending on model ordered. The control chassis incorporates solid state circuitry to operate the relays producing single pole double throw action at each point. Two control set pointers are used. Control action will occur at either point when the meter indicator coincides with the set point or is within the vicinity of the set point. With on-off action, the control will go from on to off or off to on as the meter indicator crosses the set point; with time proportioning the control action goes from on to off as the meter indicator approaches the set point while within 2% proportioning band. See Figure I for a schematic representation of control relay action.

The basic differences between the Series 273B and 273C are in the amount of control point spread and the lower point control action. The control point spread adjustment is used to control the position at which one point of control is actuated with respect to the other. On Series 273B, this adjustment can be varied from 0 to 20% of full scale above lower set point; on Series 273C, this adjustment is from 0 to 100% of full scale between set points. The desired setting depends upon the requirements of the application. The low point control action of the Series 273C is reversed from that of the Series 273B (see paragraph on "Control Action") and also has a captive indicator pointer; that is, the pointer is trapped between the two set point arms. The indicator, therefore, will not move to read the variable until the stop position, just to the left of the lower set point, is exceeded.

These instruments are suitable for applications where a control point and an alarm point are desired in a single instrument. They are also useful for such applications as heating and then cooling the process changing the power level to heaters for a fast initial response, or other applications compatible with these relay actions.

Models

Table I lists the models and modes of control available in the series. A control set pointer is provided for each control point; the green pointer for the low control point, the black pointer for the high control point.

TABLE I

Model Number	Control Point Spread	CONTROL ACTION	
		Time Proportioning	On-Off
273B	0-20%	None	Both points
273B-1	0-20%	Low point	High point
273B-2	0-20%	High point	Low point
273B-3	0-20%	Both points	None
273C	0-100%	None	Both points
273C-1	0-100%	Low point	High point
273C-2	0-100%	High point	Low point
273C-3	0-100%	Both points	None

Control Action

The two control points can be adjusted by means of setting knobs located below the scale. Within the limits of the control point spread, the two control set pointers move independently of each other. There are two indicating lamps located on the front cover assembly. The left (red) lamp lights when the low control point relay is energized; the right (green) lamp lights when the high control point relay is energized.

On start-up of the Series 273B, relay contacts are made to apply power to the process and light both signal lamps. As either set point is reached, moving in an upscale direction, the associated relays are de-energized, turning off the power to the process and turning of the signal lamps on the instrument.

Action at the lower control point of the Series 273C is the reverse of the Series 273B. On start-up, the indicator pointer will not read the actual condition of the variable, but will read approximately 5% below the lower set point value. This is because the indicator pointer is trapped between the two set points. The indicator will not move until approximately 5% below the set point is reached. Until the indicator reaches the lower set point, the relay is de-energized, the signal lamp is off, and no power is applied to the process or alarm. When set point is reached, the control action will go to the "on" position, the signal lamp will light and the indicator will respond to the actual condition of the variable. Upper control point action of the Series 273C is the same as the Series 273B, as described above. The diagram in Figure 1 shows the relay and signal lamp action of both the Series 273B and 273C.

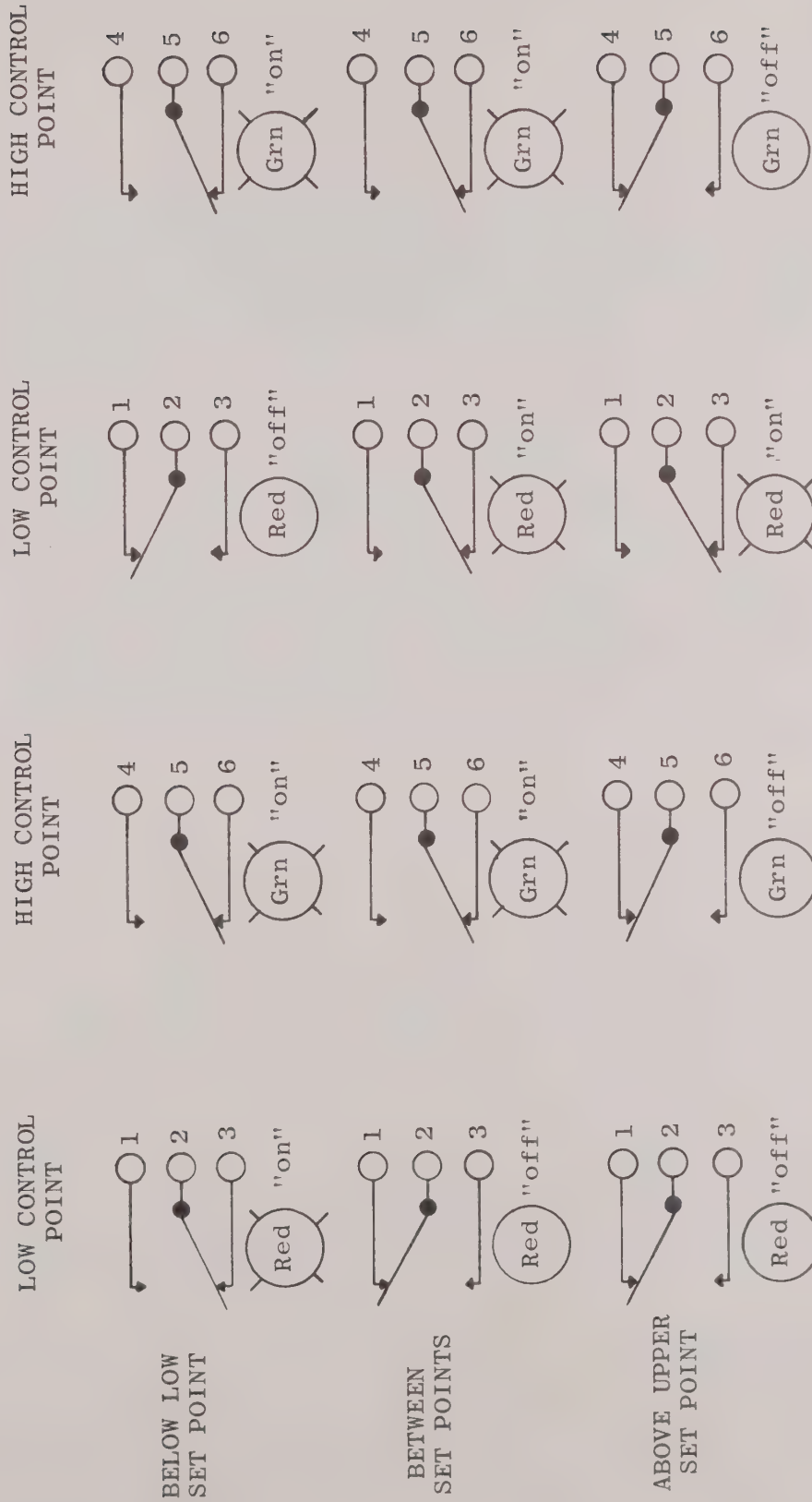


FIGURE 1 CONTROL RELAY AND SIGNAL LAMP CONDITIONS
OF SERIES 273B AND 273C.

Description

The Series 273B and 273C each have two separate control circuits, one for each set point, which utilize transistorized oscillators and silicon controlled rectifiers (SCR's). Two vanes, or flags, are suspended from the indicator pointer. These flags are used to influence the oscillator coils mounted on the upper and lower control point arms. When the coils are not interrupted by a flag (such as when the indicator is below the lower control set point -- on Series 273B -- or between set points -- on Series 273C) the transistor collector current is great enough to trigger the SCR, energizing a relay so that power is applied to the load or process. As the indicator approaches either set point, one of the flags passes between the two flat coils mounted on the individual control set point arms. The presence of the flag between the coils changes the tuning of the individual oscillator circuit. With the flag between the coils, the collector current reduces to a point where the SCR ceases to conduct, de-energizing the relay and reversing the process. As the indicator moves downscale and the flag begins to leave the coils, the collector current increases and the SCR is triggered, energizing the relay and activating the device or process. A small amount of additional transistor bias current is supplied when the relay is energized to eliminate relay chatter.

The two series of instruments are identical electronically; there are, however, physical differences. On the Series 273B, the flag used to influence the lower control oscillator coil is of sufficient length as to remain within the coil when the indicator is above the lower control set point, keeping the lower control relay de-energized. The Series 273C has a trapped indicator (mechanical stop on each control point arm). The stop on the lower control arm keeps the flag within the lower oscillator coil when the measured variable is below set point. The flag will remain within the coil, keeping the relay de-energized, until the variable exceeds the lower control point. Because of these differences, the Series 273 has reverse action from that of the 273C on the lower control point.

Time proportioning control is accomplished by changing the tuning of the transistor's emitter circuit, using a voltage variable capacitor. Varying the d-c voltage applied to the capacitor changes its capacitance and thereby the tuning of the emitter circuit. The "cycle time" adjustment regulates the d-c voltage applied over a certain time period and hence determines the cycling rate.

Time Proportioning Control

Time proportioning action, where it is provided, occurs when the flag is between one of the coils. Its position in the coils automatically determines

the percent on time versus off time during one cycle, or the period of time power is applied to the controlled load. After the indicator has reached the proportioning band (with the flag between the coils) and moves upscale towards the control set point, the percent on time decreases and the percent off time increases*. At control point, it is approximately 50% on and 50% off. This action, called "time proportioning", results in a modulation of power to the controlled load, minimizing overshoot and undershoot for close tolerance control.

An illustration of time proportioning action is shown in Figure 2. The illustration shows the 2% proportioning band of a 0-2000° meter scale ($1620^{\circ} - 1580^{\circ} = 40^{\circ} = 2\% \times 2000^{\circ}$) with full power applied to the load at 1580°F and no power at 1620°F . In the example shown, the time of one complete cycle is 8 seconds. It could be adjusted, however, to over 30 seconds or decreased to 3 seconds. The time period that power is applied to the load is controlled so that temperature variations can be minimized. On instruments equipped with time proportioning on both points, the one adjustment will establish the same cycle time for both points. This adjustment is described further under the section on "Control Adjustments."

Meter Scale
(magnified)

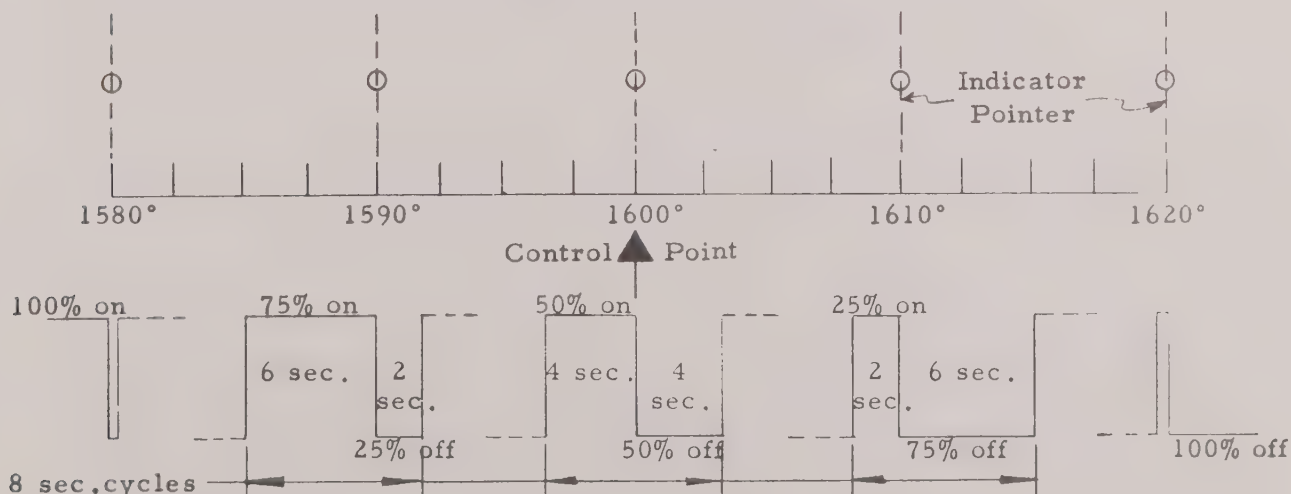


Figure 2. Example of Time Proportioning Action as the Meter Indicator Moves Upscale Through the Proportioning Band of a 0-2000°F Meter

* Applies to both control points on the Series 273B, but only the upper control point on the Series 273C. The action on the lower control point of the Series 273C is the reverse of this.

SECTION II

INSTALLATION AND START-UP

Unpacking the Instrument

This precision instrument and its associated equipment have been carefully manufactured and packed at the Factory. Remove the instrument and accessories from the packing box and check items against the packing slip. If the equipment is found to be damaged in transit, report damages to the carrier immediately. Repack in original packing box until ready for installation.

CAUTION: Handle with care.
Safeguard instrument from shock before and after installation.
Avoid oil accumulation and exposure to moisture.
Keep instrument temperature under 130°F and over 40°F.

Mounting Instructions

Locate instrument to avoid excessive vibration, shock, and temperatures outside the range of 40°F to 130°F. Avoid furnace walls, radiation of heat, machine frames, and outside walls. Provide suitable shelter against moisture and temperature extremes if installed outdoors. Refer to appropriate drawing for mounting details.

Power Wiring

The unit is supplied for either 120 or 240 volt, 50/60 cycle installation, as specified on the order. Check the rating plate for proper supply voltage. Solid wire (14 gauge) is suggested for power wiring. If stranded wire is used, tin the ends to provide secure connections.

Wiring should be in accordance with applicable electrical codes. It is recommended that a fused switch be inserted in the power line to the load. The fuse size should never exceed 5 amperes at 120 volts or 2.5 amperes at 240 volts. If load requirements are less than these amounts, the ampere rating can be less. Where maximum protection of the instrument is desired, a 1/8 ampere slow blow fuse may also be added in the power line to the instrument.

The instrument case should be grounded. This is accomplished by attaching the GRD terminal directly to a good ground, such as a cold water pipe.

CAUTION: Do not connect the GRD terminal to the neutral a-c line.

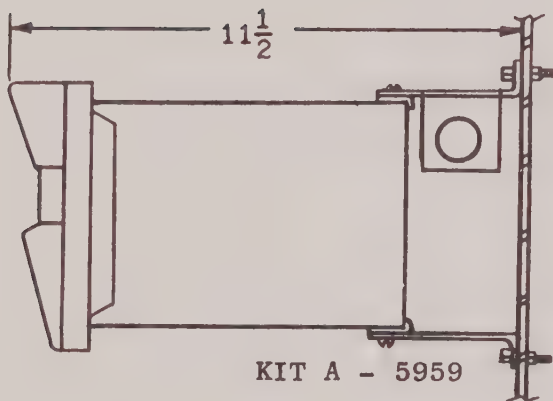
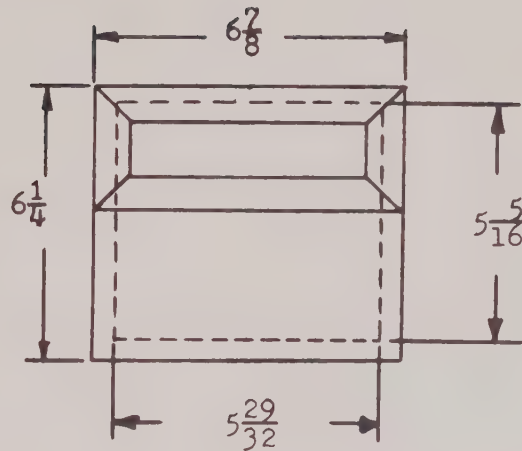
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Section II

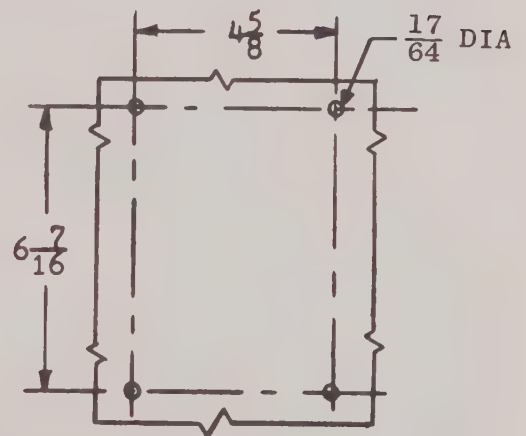
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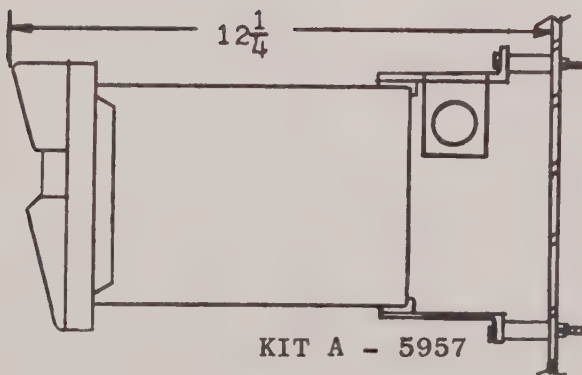
FRONT VIEW AND
CASE DIMENSIONS



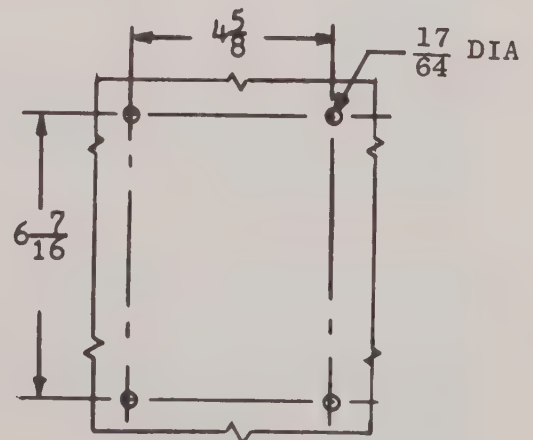
KIT A - 5959



SURFACE MOUNTING DIMENSIONS

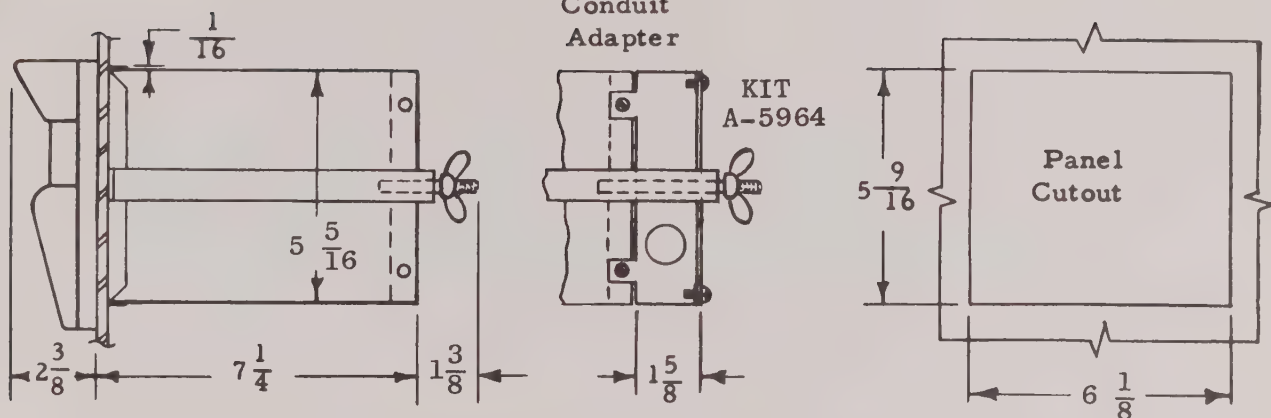


KIT A - 5957

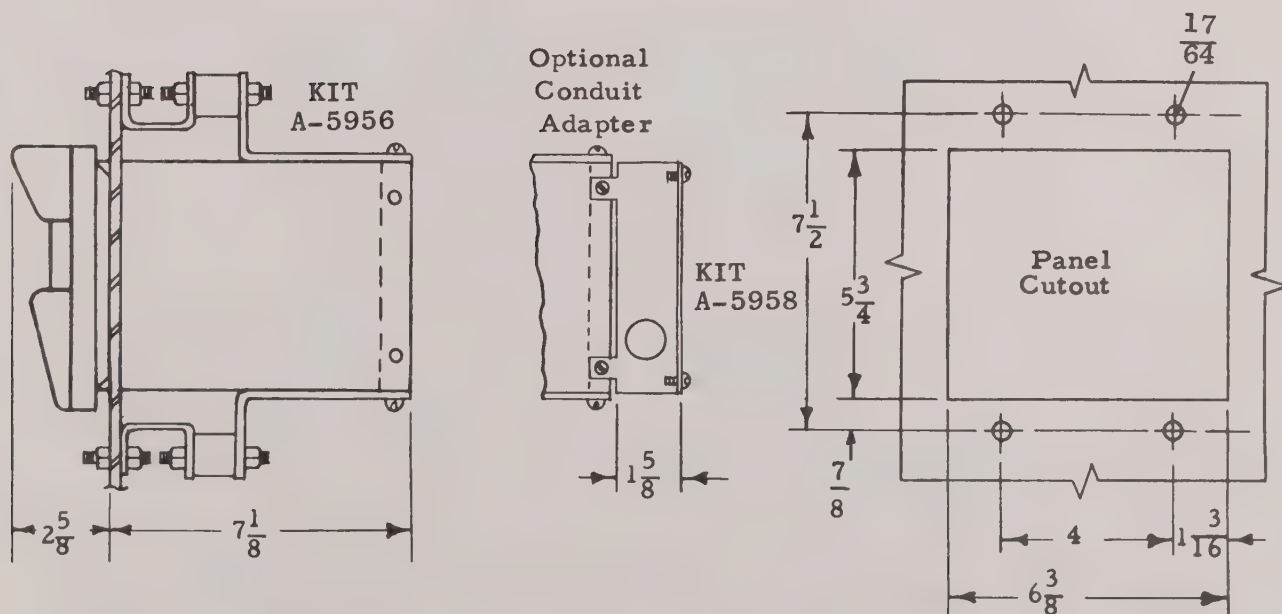


VIBRATION MOUNTING ARRANGEMENT FOR SURFACE MOUNTING

Figure 3



FLUSH MOUNTING DIMENSIONS



VIBRATION MOUNTING ARRANGEMENT FOR FLUSH MOUNTING

Figure 4

Meter Shunt Wire

After the instrument is installed, disconnect the jumper wire across terminals marked "Shunt" and "TC-". This wire is used to shunt or dampen the meter movement for protection during shipping, handling and installing the instrument, but should be removed for normal operation. Replace the shunt wire when handling or shipping the instrument and position the control set pointer fully upscale.

Thermocouple Wiring

The single unit meter and chassis plug-in assembly has a thermocouple selection feature which should be checked to see that thermocouple connections are properly made. This is done by removing the instrument from its case and noting the pin connections on the small terminal board at the rear of the meter enclosure. The leadwire marked "A" should always be connected to pin "A" and the leadwire marked "B" should always be connected to pin "B". If a base metal thermocouple is used, (Type J, T or K) the wire labeled "C" should be connected to the third pin, marked "C or D". If a noble metal thermocouple is used (Type R or S) the wire labeled "D" should be connected to this pin.

Do not run thermocouple leadwire with other power or control wiring. Leadwire may be run with thermocouple break (TCB) wires, however. Several thermocouple leadwires may be run in the same conduit if necessary.

Use only extension leadwire correct for the type of thermocouple (TC) as specified on the scale. The types most commonly specified are: Iron-Constantan (Type J), Chromel-Alumel (Type K), Platinum-Platinum 10% Rhodium (Type S), and Platinum-Platinum 13% Rhodium (Type R). Ordinary copper wire can be used only with resistance elements and the newer high temperature thermocouples. See Barber-Colman Thermocouple Catalog for a full selection of thermocouple assemblies and extension wire.

Proper polarity (+) and (-) of the leadwire must be observed to obtain correct readings. The negative wire is usually coded red. Correct polarity of the leadwire can be checked by twisting the two wires together at the far end, heating this junction with a match, and noting the deflection of the meter indicator. An upscale deflection is proof of correct polarity of the leadwire.

Secure the leadwire firmly under the terminal screws. If desired spade lugs may be used.

Line Compensating Resistor

The external resistance, for which the meter has been calibrated and as marked on the scale, is the combined resistance of the extension leadwire and thermocouple. Meters are normally calibrated for 15 ohms (Ext.Res.15 ohms), which allows for more resistance than the average length of leadwire. The balance of the resistance, 15 ohms minus the actual external resistance, is supplied as a removable compensating resistance strip located on the back of the meter plug-in socket board. The resistance value is marked on the spool which is attached at the time of the original order. Minor changes in the leadwire length can be made without appreciable error in reading because a high resistance movement is used.

Compensating resistors of other values can be obtained at nominal cost.

External Wiring Diagrams

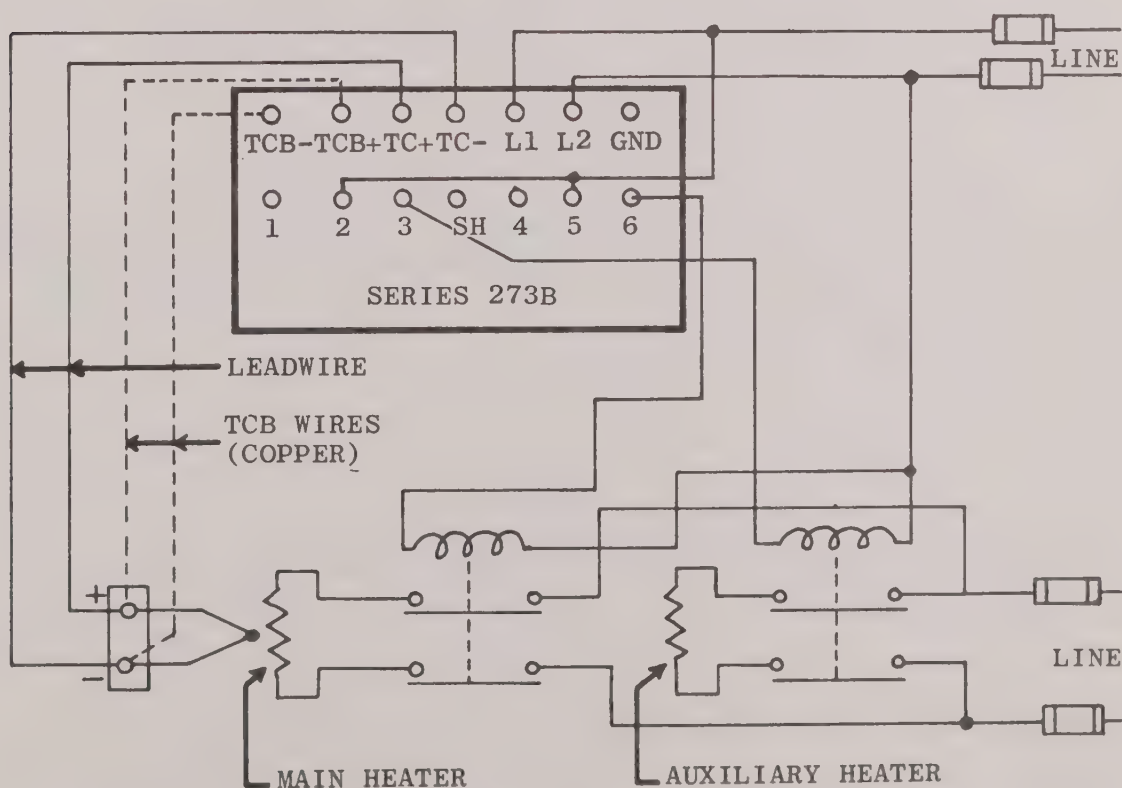


FIGURE 5
EXTERNAL WIRING DIAGRAM
SERIES 273B WITH AUXILIARY ELECTRIC HEATER

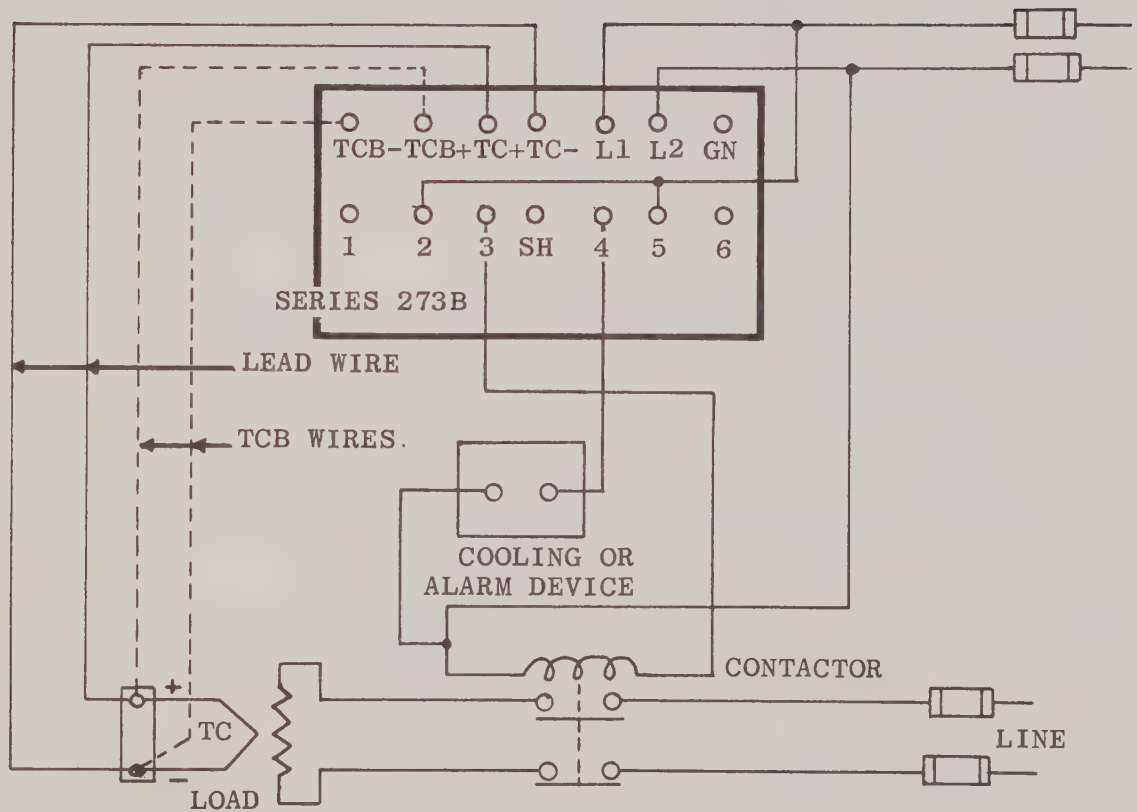


FIGURE 6
EXTERNAL WIRING DIAGRAM
SERIES 273B WITH COOLING OR ALARM ON HIGH POINT

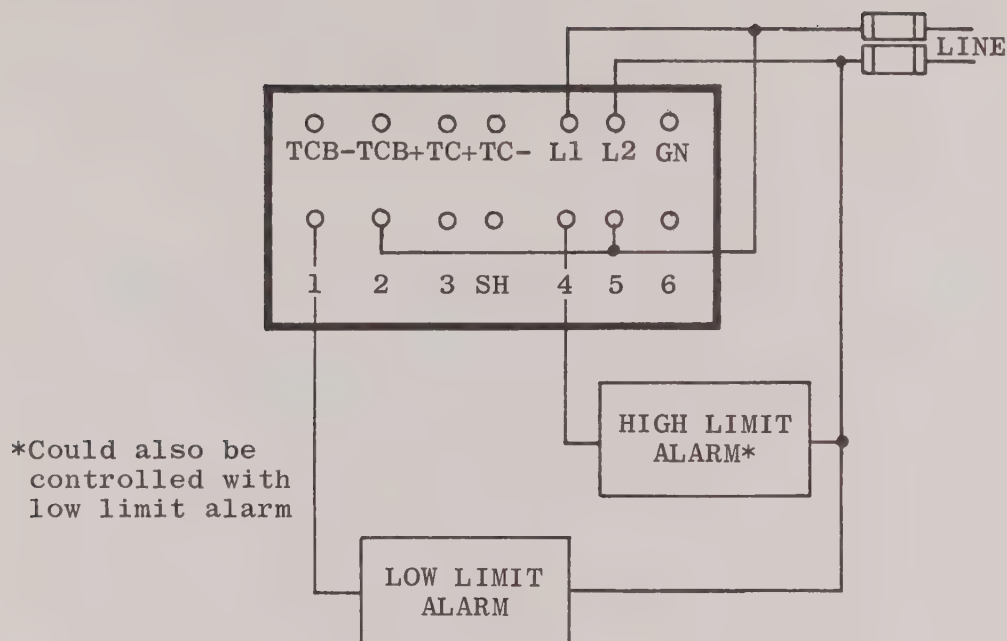


FIGURE 7A
EXTERNAL WIRING DIAGRAM
SERIES 273C WITH HIGH AND LOW LIMIT ALARMS

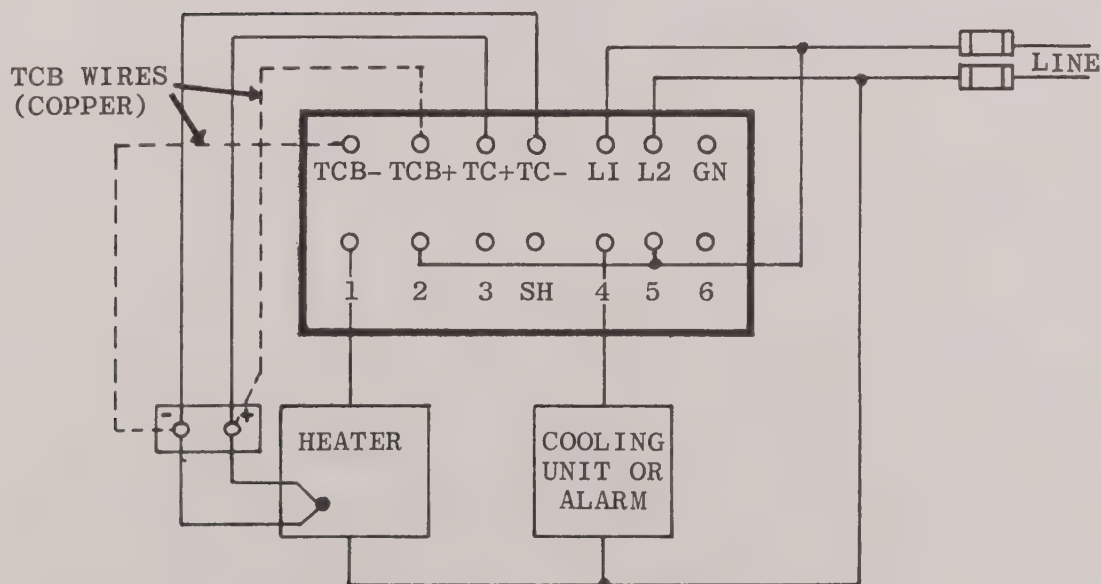


FIGURE 7B
EXTERNAL WIRING DIAGRAM
SERIES 273C WITH HEATER AND COOLING OR ALARM DEVICE

Thermocouple Break Protection (TCB)

The instrument is equipped with thermocouple break protection (TCB) to be used if desired. This protection is provided by a small d-c voltage superimposed onto the thermocouple circuit so that, in the event of a break in the thermocouple circuit, the meter movement will be driven upscale past the control set point, de-energizing the two relays. The instrument will operate in a normal manner without the TCB connected, but its use may be desired on some applications to guard against overheating in the event of an open thermocouple.

Methods of connecting TCB are shown in Figure 8. Use the required extension leadwire to make the connections between the instrument terminals and the thermocouple head. Copper wire, 16 to 20 gauge, is generally used to connect the TCB terminals to the thermocouple head, observing polarity. Wiring for TCB may be run in the same conduit with thermocouple leadwire. Although not recommended, an optional method of connecting TCB is to use jumpers at the instrument terminals with short leadwire lengths (10 feet or less). When using longer lengths of leadwire, this method may result in a noticeable error in the meter reading. The amount of TCB error must then be determined. (See section on "Meter Adjustments".)

To check for correct TCB operation, disconnect the thermocouple to simulate a broken thermocouple but leave the TCB wires connected. When the instrument is powered, TCB is functioning properly if the indicator is driven upscale above the control set pointer to cause relays to go to the above upper set point condition, as shown in Figure 1.

TCB is not effective on radiation detectors because of the compensating network in those devices. Do not connect TCB when the instrument is used in conjunction with a Series 350 Reference Voltage Source. See Series 350 Instruction Manual for complete instructions.

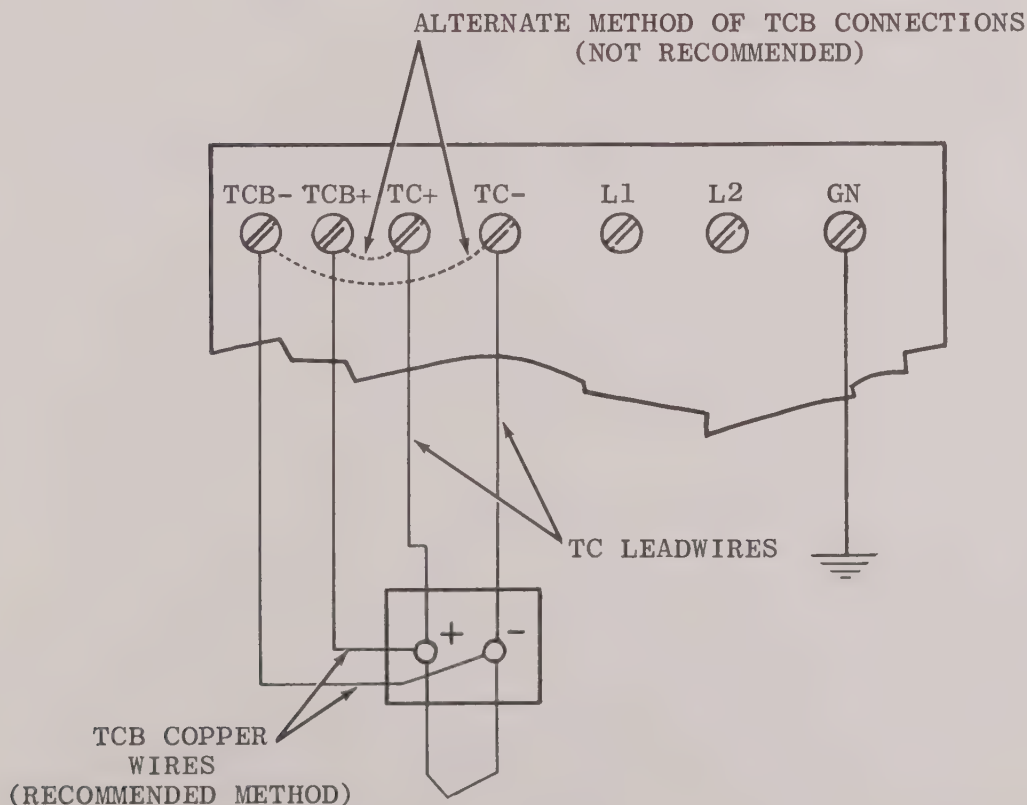


FIGURE 8
TCB WIRING METHODS

SECTION III

OPERATION

General

Both control set point indexes are independently adjustable by use of concentric setting knobs located below the scale. The meter indicator will move to indicate the temperature at the thermocouple. On the Series 273C, because the meter indicator is trapped between the two set points, the indicator will not indicate temperature until the stop position, just to the left of the lower set point, is reached. (See paragraph on "Control Action" in Section II.) Operation of the Series 273B and 273C is instantaneous because solid state devices operate without warm-up time. Refer to Figure 1 for a representation of relay and signal lamp conditions for the particular model used.

Meter Adjustments

Cold Junction Compensation:

For measuring temperature, thermocouples are the most commonly used sensing devices. They produce a voltage when there is a temperature difference between the "hot" or measuring junction and the "cold" junction located in the meter assembly. Since the difference in temperature between the hot and cold junction determines the amount of millivoltage produced, it is necessary to keep the cold junction temperature constant, or to compensate for any changes that occur at this point. The Series 273B and 273C instruments compensate for temperature changes at the cold junction through the use of a bimetallic strip. After properly adjusting for ambient temperature, further correction for ambient temperature changes need not be made.

After the instrument has been mounted, and before it has been powered, disconnect the thermocouple at one of the terminals and read the temperature indicated on the scale. The indicator should not read zero, but should come to rest at the ambient temperature, except the Series 273C if its lower set point is higher than ambient. Use a reliable mercury thermometer to determine the correct ambient temperature. (If instrument is mounted in a panel, measure the temperature inside the panel and allow enough time for the instrument to reach inside panel temperature. On Series 273C the lower control set point must be positioned at low end of scale before making this measurement.) If the pointer does not read ambient, slowly adjust the screw located on top of the meter cover until it does.

If a check of cold junction compensation is to be made after a period of operation, heat rise within the instrument housing must be allowed for. Because the rate of heat dissipation depends upon the environment, the heat rise will not be a constant, but will usually vary between 5° and 10° above the external temperature. Where close measurement accuracy is desired, a small thermometer should be placed inside the housing on top the chassis with the bulb near the meter thermocouple selection terminals. After allowing time for the inside temperature to stabilize, an adjustment should be made to set the meter indicator to the thermometer reading.

TCB Compensation:

It is necessary to compensate for TCB only if the meter tends to read significantly high when the instrument is powered. Should it be desired to compensate for this upscale deflection, the reading may be shifted downscale as explained below:

With the instrument previously adjusted for correct ambient temperature, the thermocouple should be held at a steady temperature while observing the difference in meter readings with the unit powered and unpowered. If the difference is discernable, compensation may be made with the ambient temperature adjusting screw. With the instrument powered, turn the screw to lower the indicated reading to the same point on the scale as observed when the power was off. The cold junction or ambient adjustment is thereby also changed downscale. An alternate method of making this check is by making and breaking the TCB circuit.

Control Chassis Adjustments

The controls used for final control adjustments are accessible by removing the access cover located below the set point knob. The cover is removed by pulling on the small knob in the center of the cover. Separate controls are provided for each control point. The right-hand controls are used for high control point adjustments; the left-hand controls are used for low control point adjustment. Two indicating lamps are located above the access door; the left lamp (red) is used in conjunction with the lower control relay; the right lamp (green) works in conjunction with the upper control relay.

Cycle Time (Time Proportioning Models only):

In order to obtain close tolerance control on points with time proportioning, the cycle time setting should be adjusted to the response time of the process. When using the instrument with loads that have a large thermal mass and also have a slow response time, an appropriate cycle time may be about 25 seconds. For loads that have a small thermal mass and faster response, the cycle time should be decreased. The minimum cycle time varies from about 3 seconds to

over 30 seconds. Turning the cycle time adjustment clockwise will increase the time period of one cycle, and counterclockwise will decrease it. On instruments equipped with time proportioning on both points, a separate adjustment is provided for each one.

Cycle time adjustment is made in the following manner:

When the controlled load temperature or the meter indicator has reached control set point, turn the cycle time adjustment clockwise increasing the cycle time until the meter indicator or some external monitoring device indicates that the controlled load temperature has a cyclic nature. This will show on the meter as an up and downscale movement of the indicator pointer. If cycling occurs, turn the cycle time adjustment counterclockwise in small increments, letting the controlled load stabilize after each adjustment. The cycling variation of the indicator pointer and the load will decrease, with the proper cycle time adjustment occurring just at the point where there is no perceptible indicator movement. With this setting, temperature variation of the controlled load is minimized. If some temperature variations can be tolerated, the cycle time can be increased slightly to reduce relay and contactor contact wear.

Reset:

The "reset" controls (slotted shaft) are located on each side in front of the control chassis and are accessible by removing the access cover located on the lower front of the instrument. This adjustment is always made relative to a control set point index.

On-Off Action

For models that do not provide time proportioning in conjunction with the control set pointer, the reset adjustment is used as a means of aligning the control action with the indicator. If control action does not occur when the meter indicator coincides with the control set pointer, an alignment adjustment should be made. Use a small screwdriver to reposition the reset tuning screw. Turning the reset adjustment screw counterclockwise will cause the relay and signal lamp to de-energize further downscale. Conversely, turning the reset adjustment screw clockwise will de-energize the relay and signal lamp further upscale. The proper reset adjustment occurs when this action takes place the moment the indicator pointer coincides with the control set point.

Time Proportioning Action

On models providing time proportioning in conjunction with the control set pointer, the reset adjustment is used to align the meter indicator with the control set point to correct for offset. If the meter indicator does not coincide with the set point index after the controlled load has become thermally stable, an alignment adjustment should be made. Use a small screwdriver to reposition the reset adjustment capacitor. Turning the reset adjustment counterclockwise will decrease the percent on time, thereby shifting the meter indicator downscale so as to produce a lower temperature. Conversely, turning the reset adjustment clockwise will increase the percent on time, causing the indicator to shift upscale and produce a greater temperature. The reset adjustment should be in small increments with sufficient time allowed after each adjustment to permit the controlled load to again become thermally stable. The proper reset adjustment occurs when the meter indicator coincides with the control set pointer when the load is thermally stable.

Factory Adjustments:

Two potentiometers, located on the underside of the chassis, are Factory adjusted to require approximately a 0.005" motion of the pointer to the control action to change from on to off. These settings handle the majority of applications and should not be readjusted except by a qualified instrument repair man. If it is desired to change the operating differential of the instrument relays, unplug the chassis from the housing. Turn the chassis upside down to expose the potentiometer located at the underside of the chassis. The pot on the right-hand side (looking at front of chassis) is the adjustment for the low control relay; the one on the left is the adjustment for the upper control relay. Turn applicable potentiometer clockwise with a small screwdriver to increase the differential or counterclockwise to decrease it. Too narrow an operating differential may cause relay chatter.

SECTION IV

MAINTENANCE

Removing Instrument from Housing

The meter and chassis comprise a single-unit assembly with connections to plug into the rear terminal board inside the housing. For servicing or interchange of control forms, the complete unit is removed from the housing by completely loosening the two screws on the front face and pulling forward firmly. Do not attempt to pry the unit apart from the housing.

Routine Servicing

The Series 273B and 273C instruments are well designed and manufactured of high grade components and with normal care will give uninterrupted service for a long time. It is good practice, however, to have information as to service and spare parts for emergency servicing. Where a number of instruments of this series are located together, the single meter and chassis plug-in assemblies are interchangeable to allow minimum inventory.

When trouble is encountered, the service man should familiarize himself with the process and instrument application to determine the exact function of the instrument as applied. The instrument trouble usually can be traced to two basic problems: measurement or control.

Measurement and Control Trouble

Measurement trouble can be detected by observing the pointer position. If the measured temperature is known to be in error, check the following:

1. Open or broken thermocouple, leadwire or connector.
2. Deteriorated thermocouple. Compare reading with a test thermocouple.
3. Check to see that the capacitor is properly connected between the thermocouple input terminal and the ground terminal inside the back panel of the meter-chassis unit. Also ascertain that the instrument is properly grounded.
4. Accidental shorts, grounds or moisture in the leadwire (especially with asbestos type insulation).
5. High resistance in leads due to loose connectors, poor splicing, dirty switch contacts, and other faulty connectors.
6. Problems caused by vibration or shock.

7. Meter accuracy. This can be checked with a Barber-Colman portable potentiometer.
8. Errors due to oil and grease. Do not oil or grease any part of the instrument.
9. Incorrect cold junction (ambient) setting. The correctness of this setting should be checked following any other meter servicing. See page 13.

Control trouble may be detected by observing control point and indicator pointer position. If control action does not occur at control point, do the following:

1. Check electrical connectors and correctness of line voltage. Ascertain as to whether trouble is internal or external to the instrument.
2. Adjust manual reset as described on page 15.
3. If the instrument does not operate (i.e., red lamp does not light), make sure the meter indicator is downscale from the control set point and turn the reset adjustment through its entire adjusting range. If the instrument then turns on, let the controlled load stabilize, after which proper reset adjustment can be made as described under "Control Adjustments". If the instrument does not turn on, further servicing or replacement of the unit is suggested.

Calibration Check

The instrument has been calibrated at the Factory to the specified limits of accuracy. Under ordinary circumstances, no further adjustments need be made. If, however, it is later decided to check the calibration, connect a Barber-Colman Portable Potentiometer to the thermocouple terminals and follow the steps as outlined in the portable potentiometer instruction manual.

An alternative method of making connections to the portable potentiometer is to remove the Capacitrol from its case and place it on a level surface. The leads from the portable potentiometer may then be attached to pins "B" and "C" (pin "B" is positive) on the thermocouple terminal selection board. After setting the external resistance for 15 ohms, the usual calibration procedure is followed.

SECTION V

DIAGRAMS

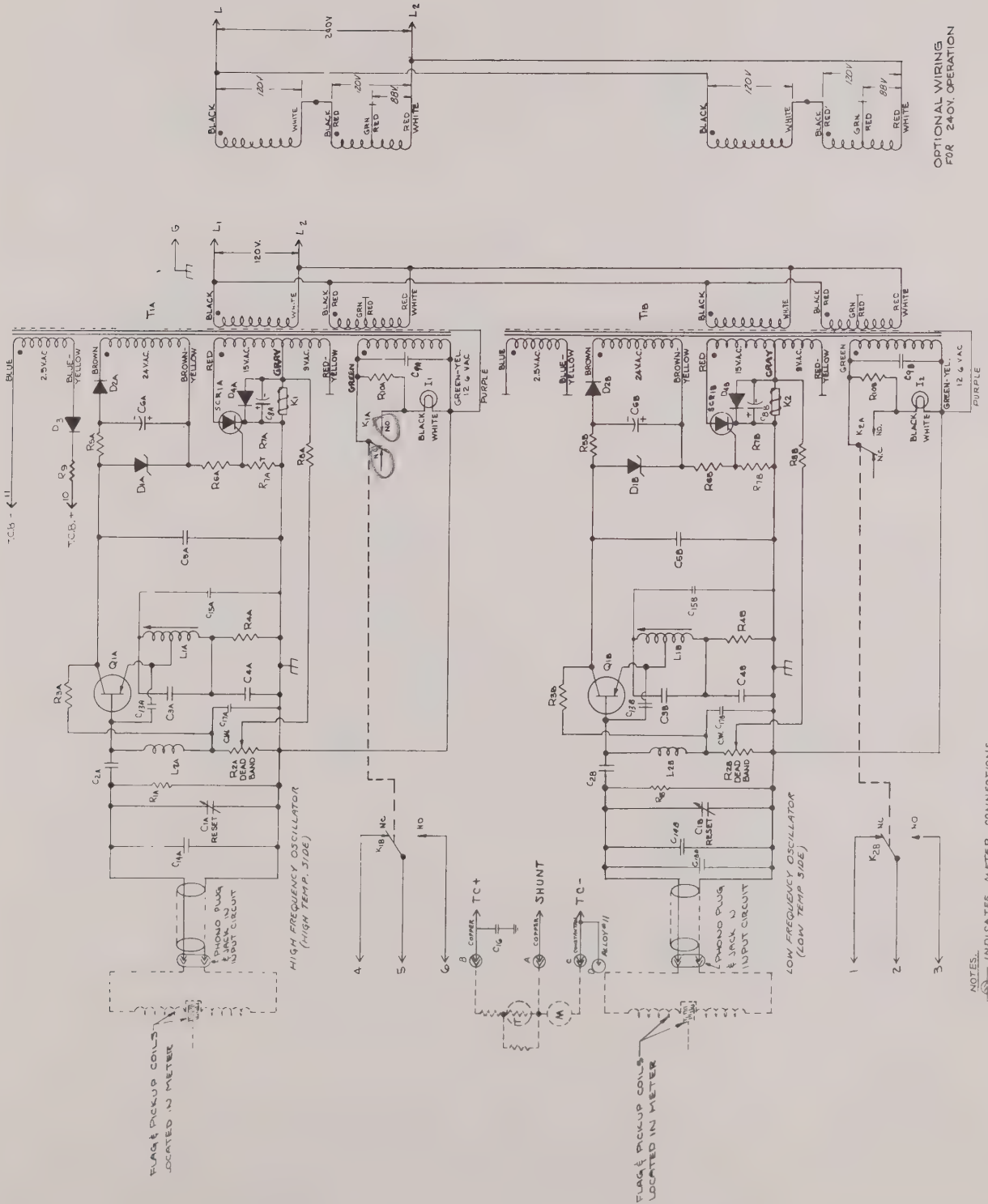


FIGURE 5-1 SCHEMATIC DIAGRAM OF SERIES 273B AND 273C

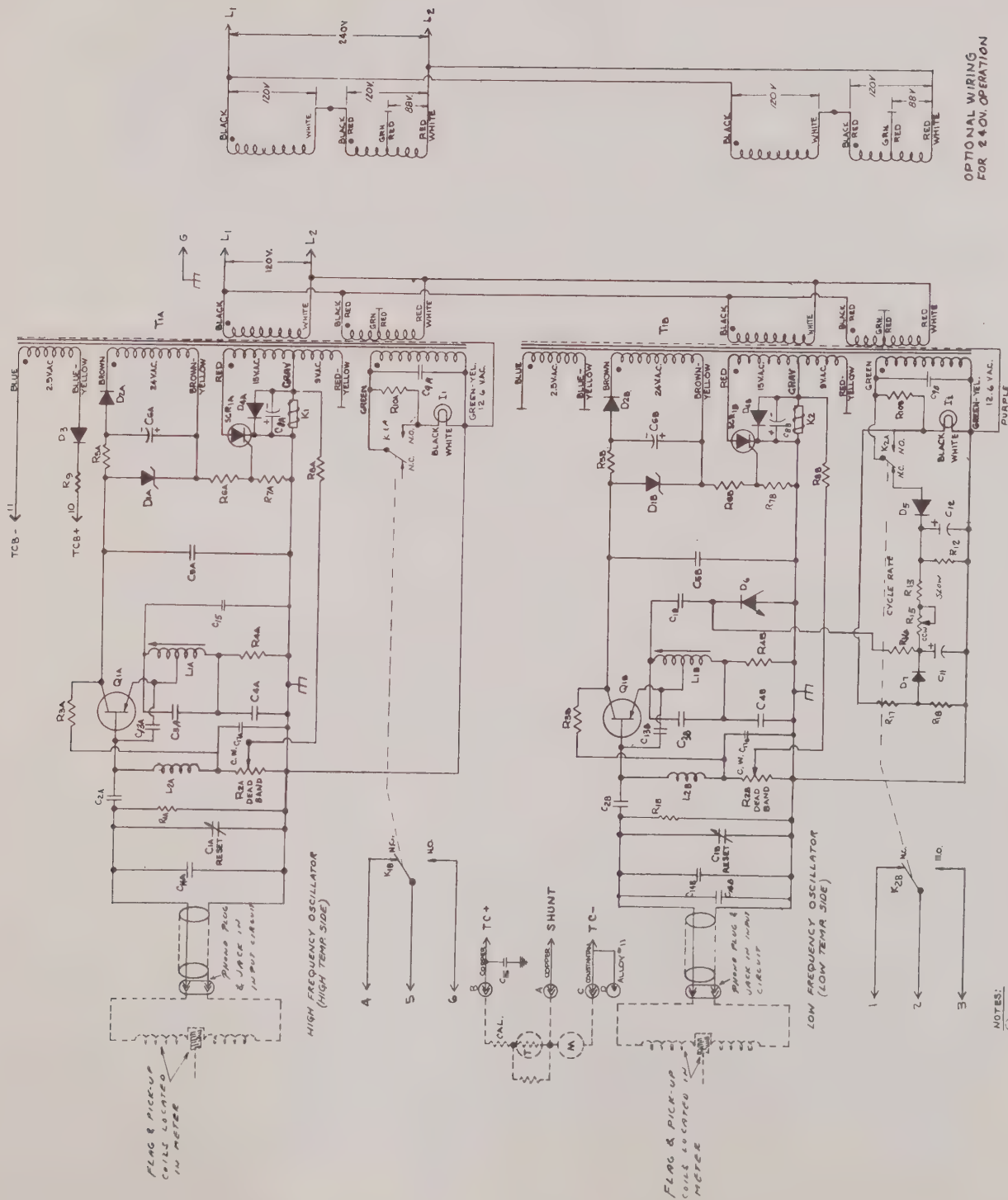


FIGURE 5-2 SCHEMATIC DIAGRAM OF SERIES 273B-1 AND 273C-1

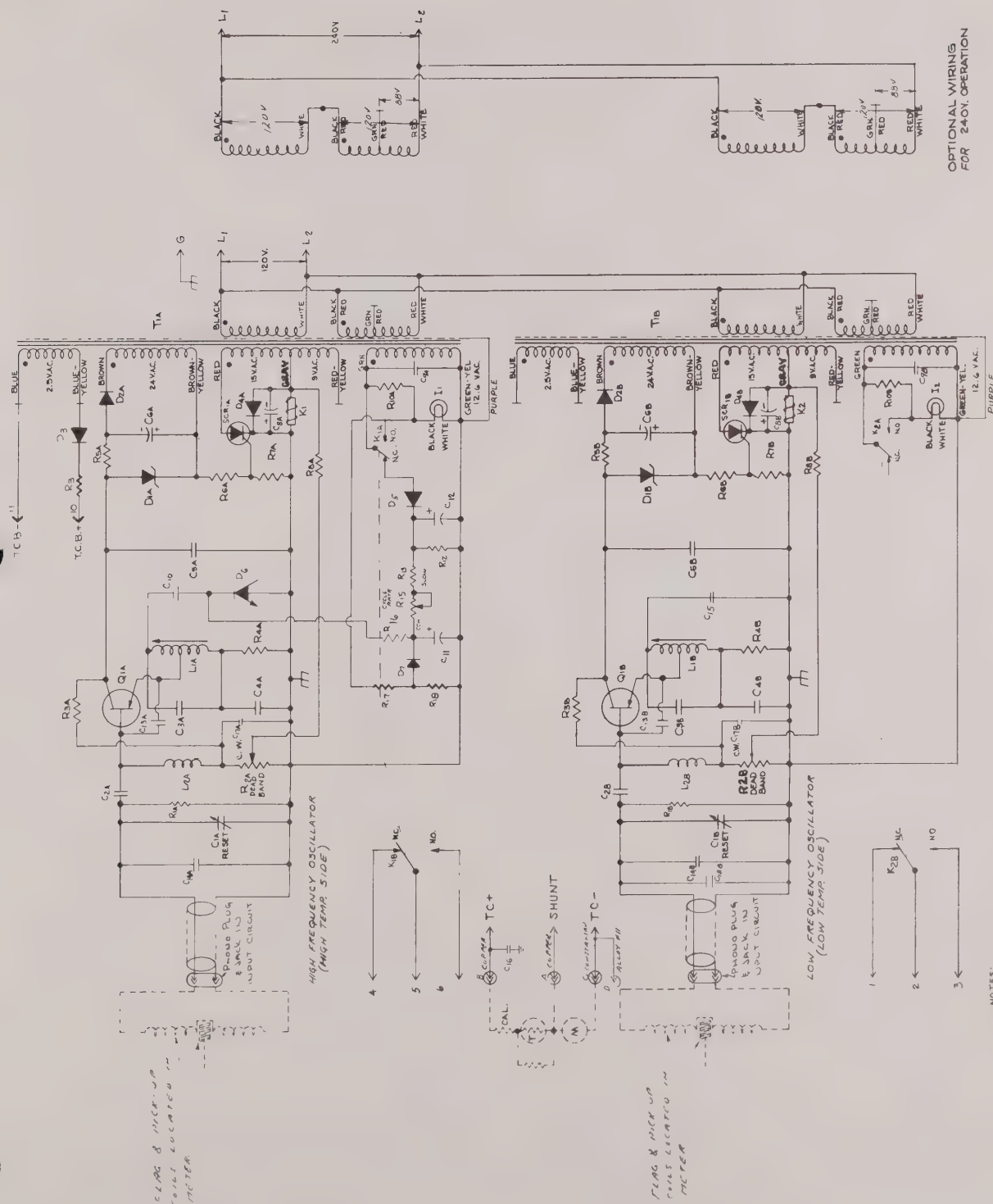


FIGURE 5-3 SCHEMATIC DIAGRAM OF SERIES 273B-2 AND 273C-2

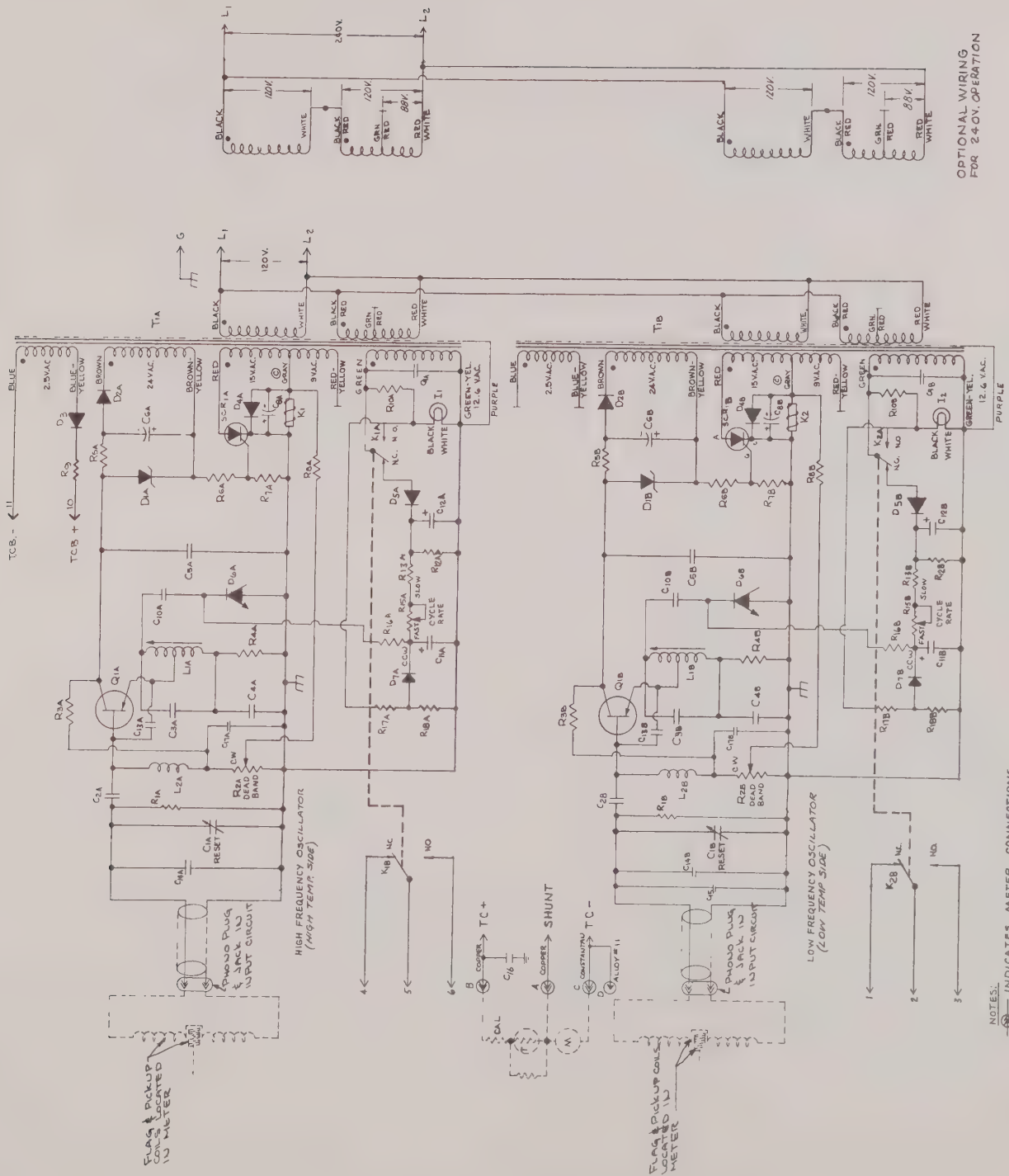


FIGURE 5-4 SCHEMATIC DIAGRAM OF SERIES 273B-3 AND 273C-3

SECTION VI

REPLACEMENT PARTS LIST

CHASSIS SECTION

Parts common to all models:

<u>Item</u>	<u>Part Number</u>	<u>Description</u>
C1A, B	39-160-1	2.9-35 μ f Variable Capacitor
C2A, B	39-76	250 μ f Capacitor
C3A	39-87	62 μ f Capacitor
C3B	39-69	100 μ f Capacitor
C4A, B	39-76	250 μ f Capacitor
C5A, B	39-103	.01 μ f Capacitor
C6A, B	39-153	50 μ f Capacitor
C8A, B	39-153	50 μ f Capacitor
C9A, B	39-196	.22 μ f Capacitor
C13A	39-89	5 μ f Capacitor
C13B	39-212	8 μ f Capacitor
C14A	39-212	8 μ f Capacitor
C14B	39-225	30 μ f Capacitor
C16	39-98	1 μ f Capacitor
C17A, B	39-76	250 μ f Capacitor
D1A, B	37-93	12 v Zener Diode
D2A, B	EYZP-384	Silicon Diode
D3	37-30	Silicon Diode
D4A, B	37-30	Silicon Diode
IL, 2	36-34	12.6 v Pilot Lamp
K1, 2	A-5521	Relay
L1A, B	41-130	2.7 μ h max. 1.2 μ h min. Factory set coil
L2A, B	41-133	22 μ h Coil
Q1A, B	31-50	Transistor (2N2188)
R1A, B	CYZR-170-1	22 k Ω Resistor
R2A, B	BYZR-93-13	1 k Ω Potentiometer
R3A, B	CYZR-170-7	27 k Ω Resistor
R4A, B	40-77	270 Ω Resistor
R5A, B	CYZR-133-2	1.5 k Ω Resistor
R6A, B	CYZR-170-35	820 Ω Resistor

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Section VI

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Parts common to all models (continued):

<u>Item</u>	<u>Part Number</u>	<u>Description</u>
R7A, B	40-200	120 Ω Resistor
R8A, B	40-109	220 k Ω Resistor
R9	CYZR-170-38	5.6 k Ω Resistor
R10A, B	CYZR-170-28	220 Ω Resistor
SCR1A, B	37-94	Silicon Controlled Rectifier
T1A, B	30-132-1	Power Transformer

Parts for Models 273B and 273C:

C15A, B	39-13-1	15 μmf Capacitor
C18B	39-67	30 μmf Capacitor

Parts for Models 273B-1, 273B-2, 273C-1 and 273C-2:

C10 (B-1 & C-1)	39-139	82 μmf Capacitor
C10 (B-2 & C-2)	39-87	62 μmf Capacitor
C11	39-163	100 μf Capacitor
C12	39-153	50 μf Capacitor
C15	39-13-1	15 μmf Capacitor
C18B	39-67	30 μmf Capacitor
D5	37-30	Silicon Diode
D6	37-60	Variable Capacitor Diode
D7	37-30	Silicon Diode
R12	40-267	220 Ω Resistor
R13	40-19-1	100 k Ω Resistor
R15	29-51-1	2 megohm Potentiometer
R16	CYZR-170-41	1 megohm Resistor
R17	40-62	2.2 k Ω Resistor
R18	CYZR-170-36	680 Ω Resistor

Parts for Models 273B-3 and 273C-3:

<u>Item</u>	<u>Part Number</u>	<u>Description</u>
C10A	39-87	62 μ f Capacitor
C10B	39-139	82 μ f Capacitor
C11A, B	39-163	100 μ f Capacitor
C12A, B	39-153	50 μ f Capacitor
C15B	39-67	30 μ f Capacitor
D5A, B	37-30	Silicon Diode
D6A, B	37-60	Variable Capacitor Diode
D7A, B	37-30	Silicon Diode
R12A, B	40-267	220 Ω Resistor
R13A, B	40-19-1	100 k Ω Resistor
R15A, B	29-51-1	2 megohm Potentiometer
R16A, B	CYZR-170-41	1 megohm Resistor
R17A, B	40-62	2.2 k Ω Resistor
R18A, B	CYZR-170-36	680 Ω Resistor



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IN 14

SERIES
273B AND 273C
CAPACITROLS

INSTALLATION AND WIRING

BARBER-COLMAN COMPANY
Industrial Instruments Div. • Rockford, Ill., U.S.A.

INSTALLATION INSTRUCTIONS SERIES 273B AND 273C

DESCRIPTION

The Series 273B and 273C Capacitrols are three-position millivolt-meter-type indicating controllers. Two relays allow control action to occur at two different points on the scale, giving three possible control combinations. Both series provide two types of control. On-off control or time-proportioning control is provided at either or both points, depending on particular model.

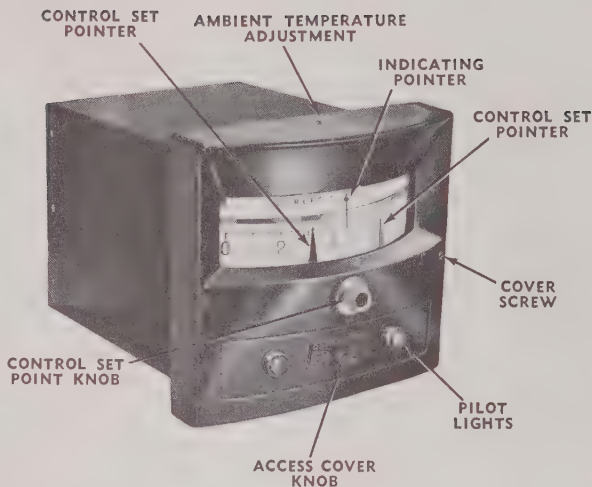
The basic differences between the Series 273B and 273C are in the amount of control point spread and lower point control action. The differences in control point spread are shown in the table below. Lower point control action differs between the two series in relay operation. The Series 273B relay remains on until the lower control point is reached; the Series 273C relay remains off until lower control point is reached. The Series 273C uses a captive indicator pointer; that is, the pointer is trapped between the two set point arms.

Control action is indicated by the two pilot lights on front of the instrument. Pilot light conditions are as follows:

Indicator Position	Series 273B Pilot Lights		Series 273C Pilot Lights	
	Red	Green	Red	Green
Below Low Point	On	On	Off	Off
Between Set Points	Off	On	On	On
Above High Point	Off	Off	On	Off

The table below lists the models and modes of control available in the series. A control set pointer is provided for each control point; the green pointer for the low control point, the black pointer for the high control point:

Model Number	Control Point Spread	CONTROL ACTION	
		Time Proportioning	On-Off
273B	0-20%	None	Both Points
273B-1	0-20%	Low Point	High Point
273B-2	0-20%	High Point	Low Point
273B-3	0-20%	Both Points	None
273C	0-100%	None	Both Points
273C-1	0-100%	Low Point	High Point
273C-2	0-100%	High Point	Low Point
273C-3	0-100%	Both Points	None



MOUNTING

Instrument is suitable for surface or flush panel mounting. Avoid furnace walls, radiated heat and outside walls. Protect unit from moisture and extreme temperatures if installed outdoors. Refer to Figure 1 for the appropriate mounting details.

CAUTION

Handle with care.

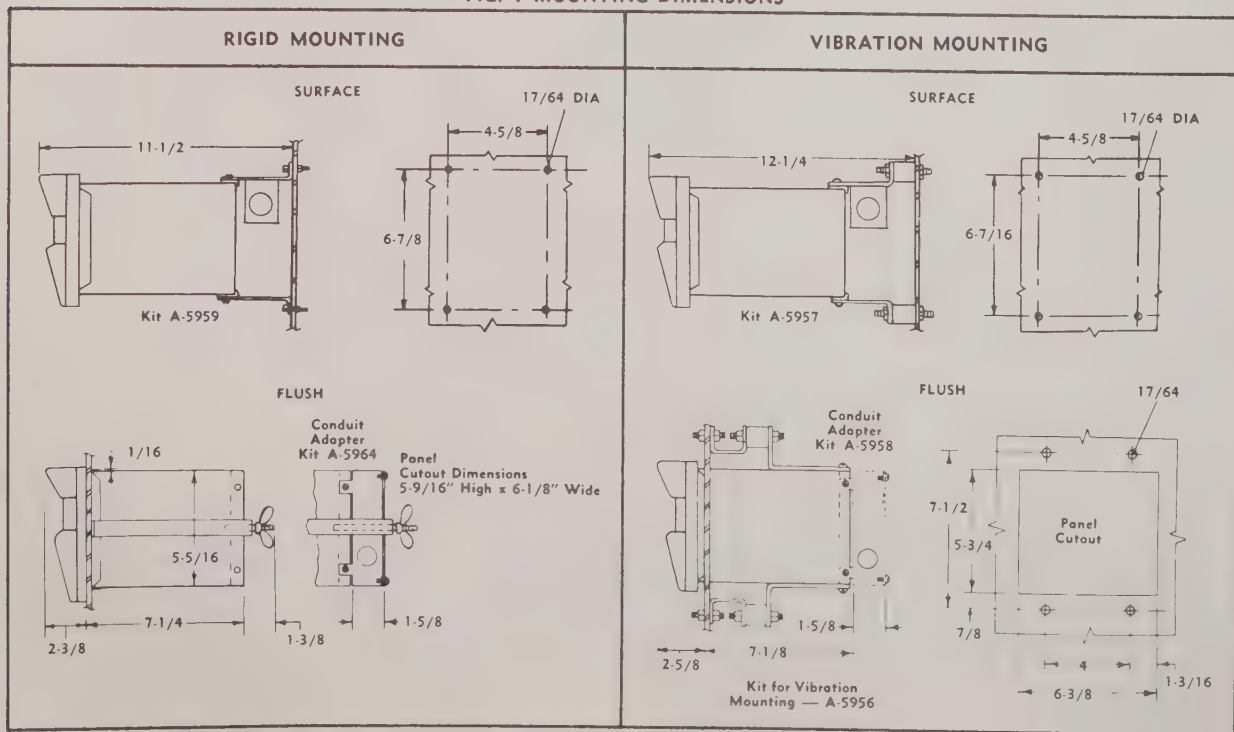
Safeguard instrument from severe shock.

Avoid oil accumulation and excessive moisture.

Temperature limitations for longest life are 40°F to 130°F.

After the instrument is installed, disconnect the jumper wire across terminals marked "Shunt" and "TC—". This wire is used to shunt or dampen the meter movement for protection during shipping, handling and installing the instrument, but should be removed for normal operation. Replace shunt wire when handling or shipping the instrument and position the red control set pointer fully upscale.

FIG. 1 MOUNTING DIMENSIONS



POWER WIRING

Instrument supplied for either 120 or 240 volt, 50/60 cycle installation, as specified on the order. Instrument should be grounded — do not connect ground (G) terminal to the neutral a-c line. Maximum instrument protection can be obtained by installing a $\frac{1}{8}$ ampere slow-blow fuse in the power supply to the instrument.

CONTROL WIRING

Terminals 1, 2 and 3 are the low point relay contacts (terminal 1 is the normally closed contact; terminal 2 is common).

Terminals 4, 5 and 6 are the high point relay contacts (terminal 4 is the normally closed contact; terminal 5 is common).

Control relay is rated at 10 amps at 120 vac, 5 amps at 240 v. On points with time proportioning, contact ratings reduced 50%. Inductive loads also reduce ratings by 50%. Typical control wiring is shown in Figure 2.

THERMOCOUPLE OR SENSING WIRING

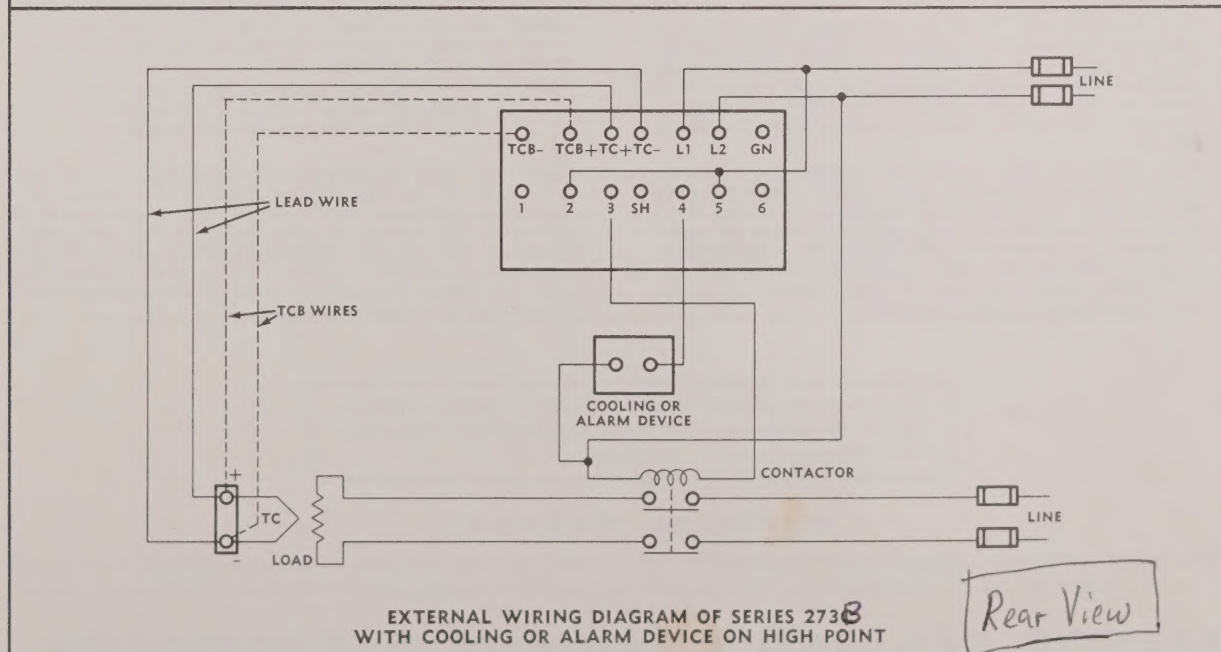
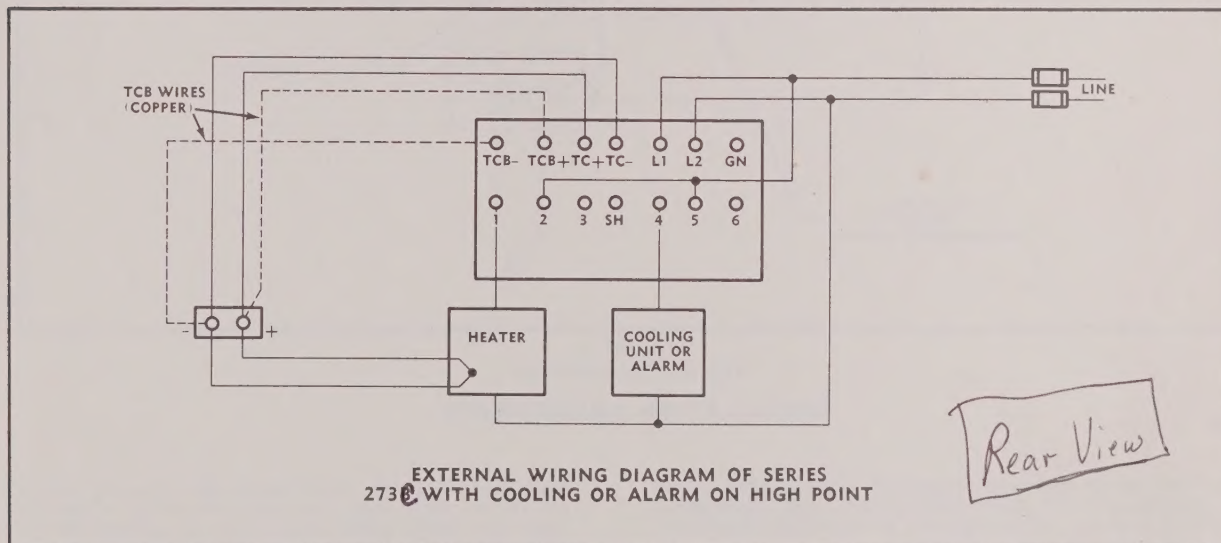
Run thermocouple wire or wires separate from power wiring. Thermocouples require special compensated leadwire. Be sure to use wire that matches thermocouple in use. Ordinary copper

wire can be used only with resistance elements and the newer high temperature thermocouples. Check installation instructions for these devices.

Proper polarity of the thermocouple wiring must be strictly observed. Indicator pointer of the instrument should move upscale when a temporary junction of the leadwire is heated. Standard model instruments require that the resistance of thermocouple and leadwire should equal "Ext. Res." marked on the scale pan (usually 15 ohms). If not, the external resistance compensator located on the meter plug-in socket board should be equal to the difference.

The single unit meter and chassis plug-in assembly has a thermocouple selection feature which should be checked to see that thermocouple connections are properly made. This is done by removing the instrument from its case and noting the pin connections on the small terminal board at the rear of the meter enclosure. The leadwire marked "A" should always be connected to pin "A" and the leadwire marked "B" should always be connected to pin "B". If a base metal thermocouple is used (Type J, T or K), wire marked "C" should be connected to the third pin "C or D". If a noble metal thermocouple is used (Type R or S), wire marked "D" should be connected to pin "C or D".

FIG. 2. CONTROL WIRING



THERMOCOUPLE BREAK PROTECTION (TCB)

The Series 273B or 273C is equipped with thermocouple break protection to be connected if desired. Copper wire, 16 to 20 gauge, is generally used. The recommended method is to make connections to the thermocouple connection head — see Figure

3. An optional method, using jumper connections, is effective, but may cause some calibration error if thermocouple leadwire is more than 10 feet long.

Polarity must be carefully observed. If properly connected, the meter will drive upscale past the control set point if the thermocouple circuit is broken.

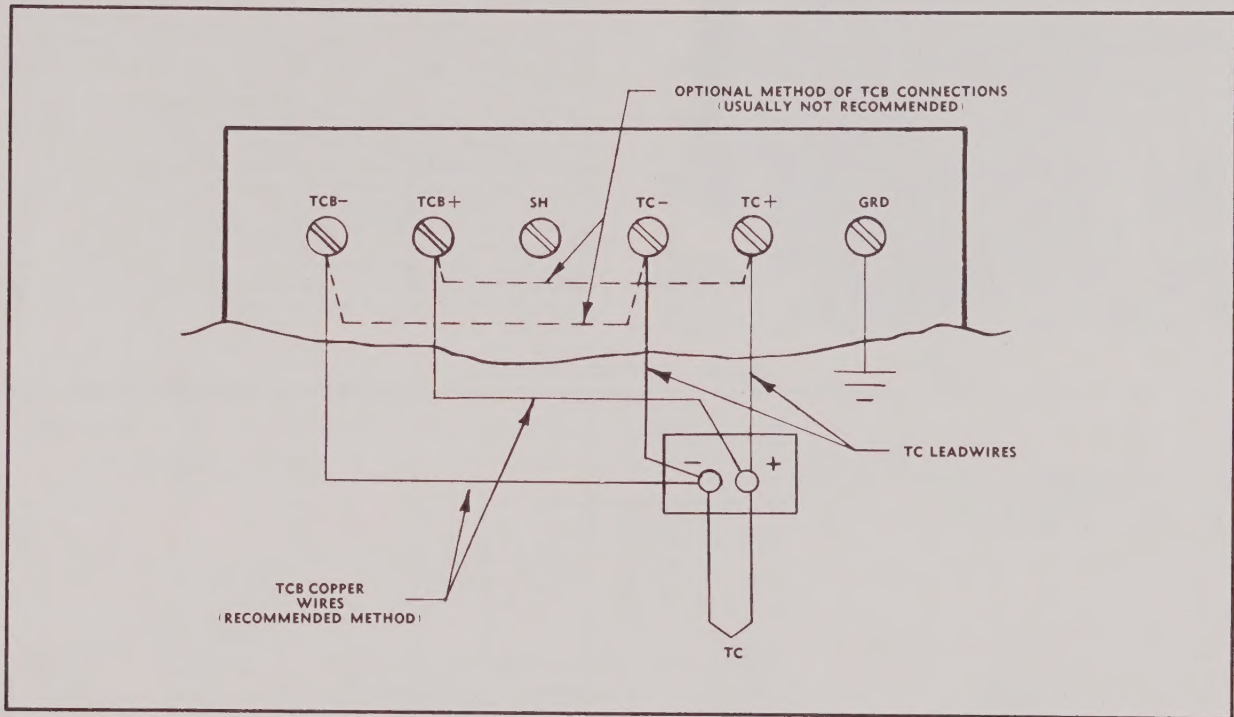


FIGURE 3
TCB WIRING METHODS
INSTALLATION ADJUSTMENTS

1. Meter should read room temperature — NOT ZERO — with thermocouple and thermocouple break wiring disconnected. If it does not, adjust the screw on top of the front cover until proper reading is obtained.
2. TCB Compensation: With the instrument powered, TCB may cause the meter to read slightly higher than when the meter is unpowered. If desired, correction can be made using the adjusting screw on top the front cover. With power on, turn the screw to lower the indicated reading to the same point on the scale as obtained when the power was off.
3. Both control set point indexes are independently adjustable by use of concentric setting knobs located below the scale. On the Series 273B, the lower set pointer is limited in its travel to no more than 20% of scale length below the upper set pointer. On the Series 273C, because the meter indicator is trapped between the two set points, the indicator will not show actual temperature until the stop position, just to the left of the lower set point, is reached.

4. Reset adjustments (the slotted shafts on either side of control chassis inside front access door) should be adjusted to assure that control action occurs when the indicator pointer and a control set point are aligned. Adjustment can be made relative to either or both set point indexes. The left-hand adjusting screw is used for the lower point; the right-hand screw is used for the upper point.

NOTE: Good practice dictates that the process and control system should be allowed to reach maximum stability before making final adjustments.

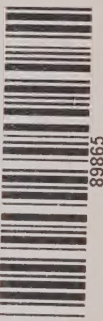
5. Cycle time (used on time proportioning models only) should be adjusted to suit the response time of the process. The cycle time adjustment can be varied from approximately 3 seconds to 30 seconds. Turning the cycle time adjustment clockwise will increase the time period of one cycle, and counterclockwise will decrease it. Cycle time should be adjusted no faster than necessary to allow the meter indicator to hold steady without oscillations.

If more information is desired, request Instruction Manual 1211.8 IN 6 from your local Barber-Colman Branch Office. See the yellow pages of your phone book.

MATERIAL WARRANTY

All equipment except tubes, photocells, and thermocouples, which within one year from date of shipment is found to have been originally defective, will be repaired (replaced if necessary) free of charge if returned prepaid to the Factory at Rockford, Illinois.

BARBER-COLMAN COMPANY Industrial Instruments Division
Rockford, Illinois, U.S.A. 61101





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MP MASTER



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